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Atmospheric monitoring at the Pierre Auger Observatory using the upgraded Central Laser Facility

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The Fluorescence Detector (FD) at the Pierre Auger Observatory measures the intensity of the scattered light from laser tracks generated by the Central Laser Facility (CLF) and the eXtreme Laser Facility (XLF) to monitor and estimate the aerosol optical depth ($\tau(z,t)$). These measurements are important to have unbiased and reliable FD reconstruction of the energy of the primary cosmic ray, and the depth of the maximum shower development.

In 2013 the CLF was upgraded substantially with the addition of a solid state laser, new generation GPS, a robotic beam calibration system, better thermal and dust isolation, and improved software. The upgrade also includes a back-scatter Raman LIDAR receiver, capable of providing independent measurements of $\tau(z,t)$.

We describe the new features and applications of the upgraded instrument, including an automated energy calibration system, a steered firing system used for arrival direction studies, and the atmospheric monitoring measurements. We also present the first results after the upgrade using three different procedures to calculate $\tau(z,t)$. The first procedure compares the FD hourly response to the scattered light from the CLF (or XLF) against a reference hourly profile measured during an extremely clear night where zero aerosol contents are assumed. The second procedure measures $\tau(z,t)$ by comparing simulated FD responses under different aerosol attenuation parameters and selecting the best fit to the actual FD response. The third procedure uses the new Raman LIDAR receiver in-situ to measure the back-scattered light from the CLF laser.

The comparison shows a good agreement for the first and second procedures for all FDs located at similar distances from the facilities. However we found higher values of $\tau(z,t)$ using the Raman measurements. This difference may indicate that the assumption of a zero aerosol content during the reference night selection may not be accurate.

Collaboration

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